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A LOWER TO MIDDLE ORDOVICIAN AGE FOR THE HOTHAM GROUP, EASTERN VICTORIA

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Abstract: In the Tabberabbera district of eastern Victoria, Ordovician sediments comprise a 4-5 km thick succession of quartz-rich turbidites named the Hotham Group. Conodonts and graptolites occur in rare cherts and black shales which are interbedded with the otherwise unfossiliferous succession. A Lower to Middle Ordovician (Darriwilian) age is suggested. The oldest strata are ribbon cherts of probably Early Tremadocian (pre-Lancefieldian) age that occur as tectonic slices along the Wonnangatta Line, a major fault to the west of Tabberabbera.

Most age determinations of the Ordovician of eastern Victoria are based on sparsely-distributed Middle and Upper Ordovician graptolite faunas (Vandenberg 1978). The occurrence of Lower Ordovician graptolites in the northern part of the Omeo Metamorphic Complex (Kilpatrick & Fleming 1980) represents the only early Ordovician age record from the entire region.

This paper considers the Hotham Group of the Tabberabbera district (Fig. 1) and the conodonts and graptolites that have been discovered within the cherts and siliceous mudstones of this unit. Although faunas are sparse and often poorly preserved, sufficient diagnostic taxa have been found to show that much of the succession is of Lower to Middle Ordovician (Darriwilian) age, not Upper Ordovician as previously suggested (e.g., Richards & Singleton 1981).

STRATIGRAPHY AND SETTING

The Ordovician succession between the Omeo Metamorphic Complex and the Howqua Zone was named the Hotham beds by Vandenberg and O'Shea (1978). Regional mapping and palaeontological studies considered herein have shown that the Hotham beds constitute a lithostratigraphic unit that, in some areas, can be subdivided into formations. Therefore, we propose that the Hotham beds be renamed the Hotham Group. The unit consists of a thick, monotonous succession of interbedded quartz sandstone and mudstone with rare, generally thin (<2 m) intervals of black shale and radiolarian chert (Fig. 2).

In the Tabberabbera Sub-zone, the Hotham Group is divided by the Wonnangatta Line into two contrasting lithological and structural domains (Fig. 1). The Wonnangatta Line is a major fault zone marked by a tectonic melange up to 2 km in width (Fergusson in prep.). The tectonic melange is derived from the *in situ* tectonic fragmentation of interbedded quartz sandstone and mudstone of the Hotham Group. Within the melange there are many fault-bound fragments of ribbon chert which are up to 2-3 km in length. The ribbon cherts consist of radiolarian chert interlayered with laminae of mudstone in a distinctive rock type unknown elsewhere in the Tabberabbera Subzone. The cherts are rich in pyrite and detrital organic matter.

The Hotham Group, south-west of the Wonnangatta Line, consists of a monotonous succession of interbedded turbiditic quartz sandstone and mudstone. Black shale is known only from one locality (PL 2947, Fig. 1B) and cherts are absent. In the Freestone Creek area, 30 km to the southwest of Tabberabbera, the Hotham Group is 3.6 km thick and is divisible into three units (Fig. 2). These are: (i) a lower unit of monotonous interbedded sandstones and mudstones; (ii) a middle unit of passage beds with mudstones interbedded with intervals of mudstones and interbedded sandstones up to 20 m thick; and, (iii) an upper unit of mudstone.

North-east of the Wonnangatta Line, the Hotham Group is a thick, monotonous unit of quartz turbidites that contain thin horizons of black shale and chert but no mappable horizons of mudstone. Black shales and cherts are commonly 1-2 m thick with two much thicker intervals of black shale in the Sandy Creek area (Fig. 2). The cherts and black shales are gradational and consist mainly of quartz with variable quantities of muscovite. The black colour of the shale reflects small quantities of carbonaceous material. Both lithologies contain abundant Radiolaria, although they are affected by recrystallisation and dissolution. Some cherts contain sponge spicules, although these are always less abundant than the Radiolaria.

The Hotham Group was affected by one major deformation south-west of the Wonnangatta Line, whereas in the north-eastern domain it has suffered multiple deformations (Fergusson in prep.). The structure and sedimentology of the Group will be described in more detail elsewhere.

PALAEONTOLOGY

A detailed examination of numerous outcrops of chert and siliceous mudstone within the study area has

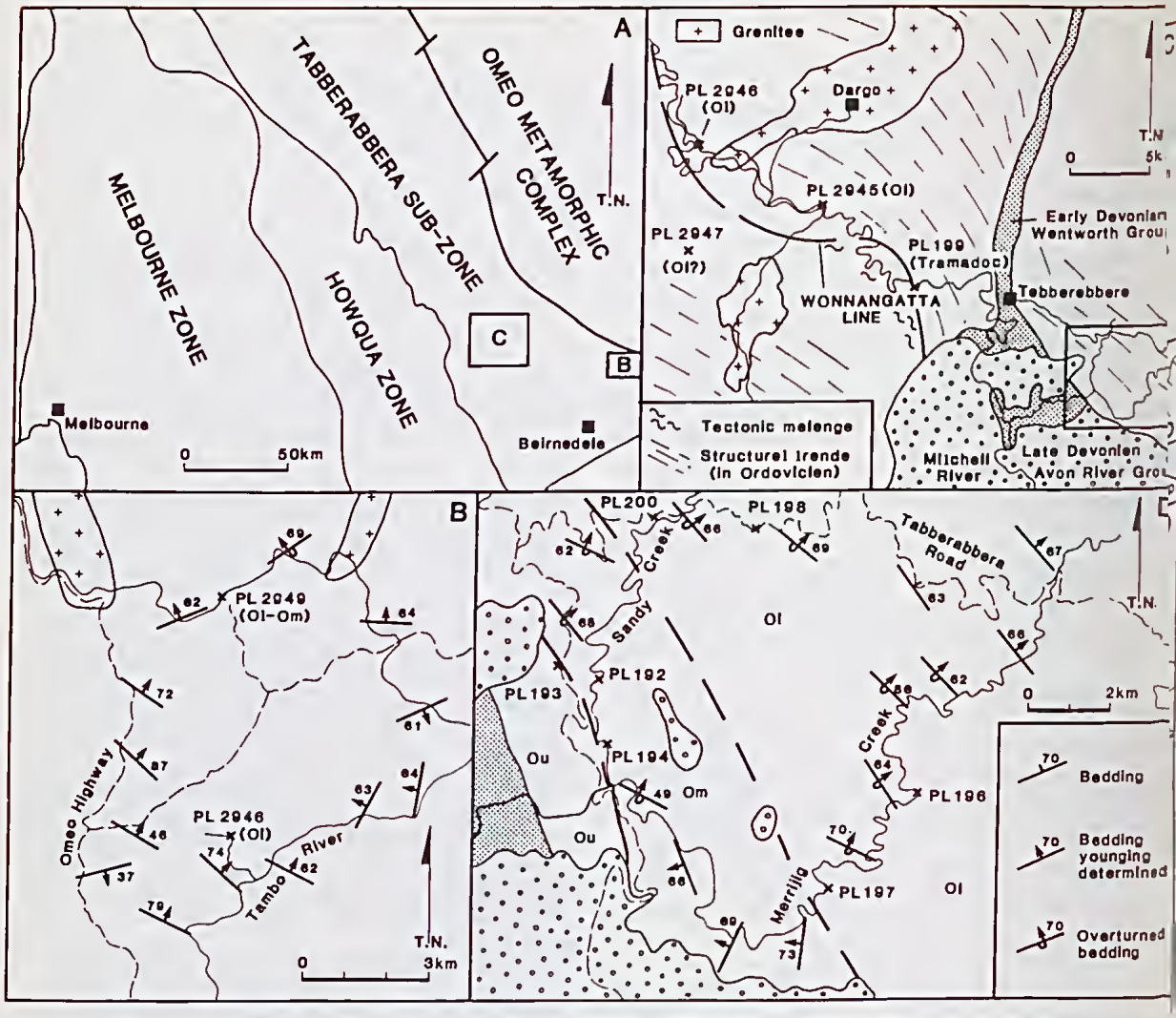

Fig. 1—A, Major geological subdivisions of the Lachlan Fold Belt in central eastern Victoria. B, Geology of the Tambo River area with Lower and Middle Ordovician (Ol and Om respectively) fossil localities. C, Geology of the Tabberabbera district. D, Detail of the Sandy Creek area showing the Lower (Ol), Middle (Om) and Upper (Ou) Ordovician fossil localities.

yielded sufficient fossil material to show that the greater part of the Ordovician is represented. The cherts were studied using bedding-parallel polished slabs and thick (ca. 1.0 mm) petrographic sections. The latter were examined with a combination of incident and transmitted light. Many of the cherts grade into siliceous mudstone opaque in thick sections. If these rocks retained any bedding-parallel partings they were split and examined with a binocular microscope and incident light.

The majority of conodonts in the cherts and mudstones are preserved as empty or residue-filled moulds with little, obviously-preserved, morphological detail. A combination of mechanical and chemical preparation using fine needles and concentrated hydrochloric acid was used to clean out some of the moulds. Casts of the conodont elements were prepared using latex rubber solution and these replicas then examined under a scanning electron microscope with excellent resolution of morphological detail (e.g., Fig. 3F).

The oldest rocks in the region are fault-bound ribbon cherts along the Wonnangatta Line near the Mitchell River (Museum of Victoria invertebrate fossil locality—PL 199). They contain abundant, minute clusters of paraconodonts, simple cone euconodonts, sponge spicules, radiolarian fragments and inarticulate brachiopods. Large and complex conodont elements are restricted to rare specimens of *Cordylodus proavus* (Fig. 3A) and *C. intermedius*. *C. proavus* is the index species for the latest Cambrian/Early Ordovician *C. proavus* Zone of midcontinent North America (Miller *et al.* 1982) and ranges through the early Lower Tremadocian. *C. intermedius* first appears early in the *C. proavus* Zone (Fortey *et al.* 1982) and ranges into the Upper Tremadocian. These rocks are best assigned a Lower Tremadocian (pre-Lancefieldian) age. They represent

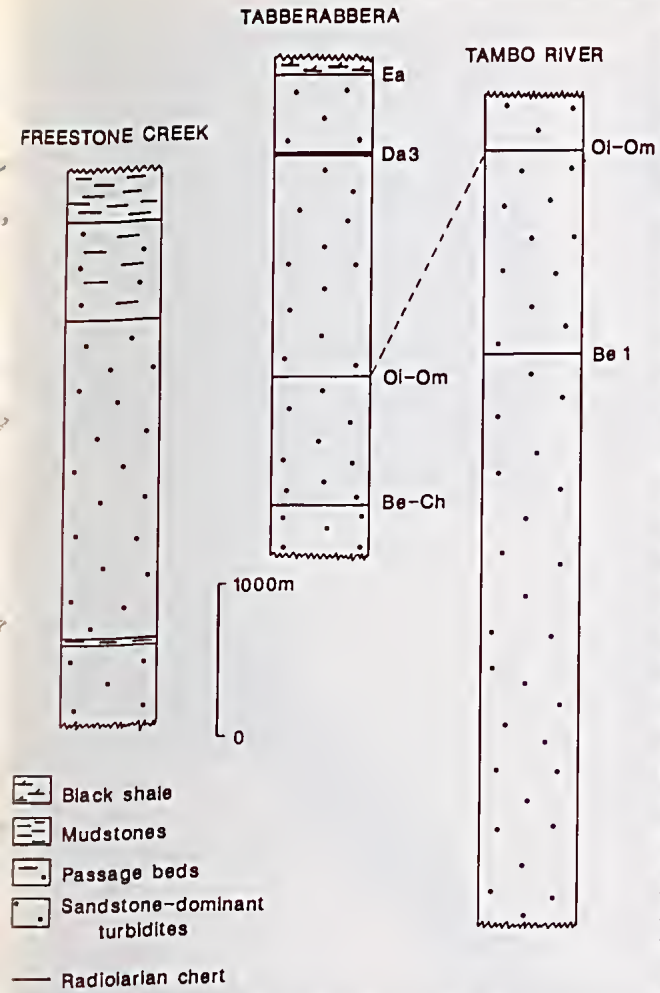

Fig. 2—Schematic stratigraphic columns for the Hotham Group from Freestone Creek, Tabberabbera (Sandy Creek) and Tambo River.

the oldest exposed sediments east of the Howqua Zone where a Cambrian succession has been recognized. Although these cherts are faultbound their location is consistent with them forming the base of the Ordovician quartz turbidite succession (Fig. 1C).

Previous age determinations from the Hotham Group north-east of the Wonnangatta Line are restricted to several narrow bands of late-Darriwilian to Eastonian graptolitic black shales south-east of Tabberabbera (Talent 1963). Lower Ordovician strata are here reported to be widespread throughout this domain (Fig. 1) as well. A thin black shale and chert unit near Dargo (PL 2946) has yielded the graptolites *Tetragraptus approximatus* and four-branched *T. fruticosus* (Fig. 3C). These are the zonal species for the Lower Ordovician Bendigonian Bel Zone. The fauna is of the same age as that recorded by Kilpatrick and Fleming (1980) near Eskdale 120 km to the north. The shales also contain numerous conodonts and phyllocarids. Conodont species include *Paracordylodus gracilis* (Fig. 3B), *Prioniodus elegans*, *Oepikodus* sp. cf *O. communis*, and several coniform conodont species. This fauna is best correlated with the lower Arenig *Prioniodus elegans* Zone of Sweden and eastern North America (Löfgren 1978; Landing 1976). Along the Dargo Road 8 km to the south-east a thin nodular chert in a mudstone sequence (PL 2945) also contains *Paracordylodus gracilis*.

Strata of similar age also occur 75 km to the east at Peters Creek (PL 2948) (Fig. 1B) where a thin black shale and chert band contains *Prioniodus elegans* and *Paracordylodus gracilis* (Fig. 3E). To the north of this locality, on the Tambo River, ribbon cherts contain *Periodon flabellum* indicating a late Lower or early Middle Ordovician age (PL 2949). The regional trend indicates this area contains a considerable thickness of Lower Ordovician strata (Fig. 2).

South-west of Tabberabbera (Figs 1C, D) the oldest fossils were found in the region of Merrijig Creek with the succession younging to the west. Lower Ordovician conodonts occur in ribbon cherts outcropping in Merrijig Creek (PL 196) and in siliceous black mudstones on the Tabberabbera Road (PL 198). Here *Oepikodus evae* and rare *Bergstroemognathus extensus* (Fig. 3D) are characteristic of strata correlated with the Swedish *O. evae* Zone in North America (Landing 1976) and central Australia (Cooper 1981). These species also occur in Upper Bendigonian and Chewtonian graptolitic shales of central Victoria (Vandenberg & Stewart 1983). On the Tabberabbera Road (PL 200), a 15 cm thick yellow chert band contains abundant conodonts of the *Periodon* lineage. Similar conodonts also occur in black ribbon cherts to the south in Merrijig Creek (PL 197). These assemblages are of late Lower Ordovician or early Middle Ordovician (Darriwilian) age.

Along Sandys Creek and Sandys Creek Road, several localities contain late Darriwilian and early Gisbornian conodonts and graptolites. In Sandys Creek (PL 192) a thin mudstone bed contains *Polonodus*, *Histiodella*, *Spinodus spinatus*, *Periodon aculeatus* and a single specimen of *Pygodus serrus*. The fauna is similar to that found with Darriwilian Da. 3 Zone graptolites in central Victoria and best correlates with the *Pygodus serrus* Zone based in Sweden (Bergström 1971) which has a Llanvirn age. Further south in Sandys Creek an outcrop of black shale (PL 194) contains a sparse late Darriwilian (Da. 4) graptolite fauna (Thomas, in Talent 1963, loc. 30) and abundant *Periodon aculeatus*.

Above Sandys Creek on Sandys Creek Road the sequence passes conformably into early Gisbornian mudstones (PL 193) containing *Pygodus serrus* and *P. anserinus* (Fig. 3F). Eastonian graptolites have been recorded to the west of Sandys Creek Road (Thomas, in Talent 1963). The distribution of fossil localities in the Merrijig Creek and Sandys Creek area indicates there is a complete succession ranging in age from Lower Ordovician Bendigonian (Be. 4) or Chewtonian (Ch. 1) to Upper Ordovician, Eastonian. The stratigraphic range of key conodont and graptolite taxa recovered from the Hotham Group is summarized in Fig. 4.

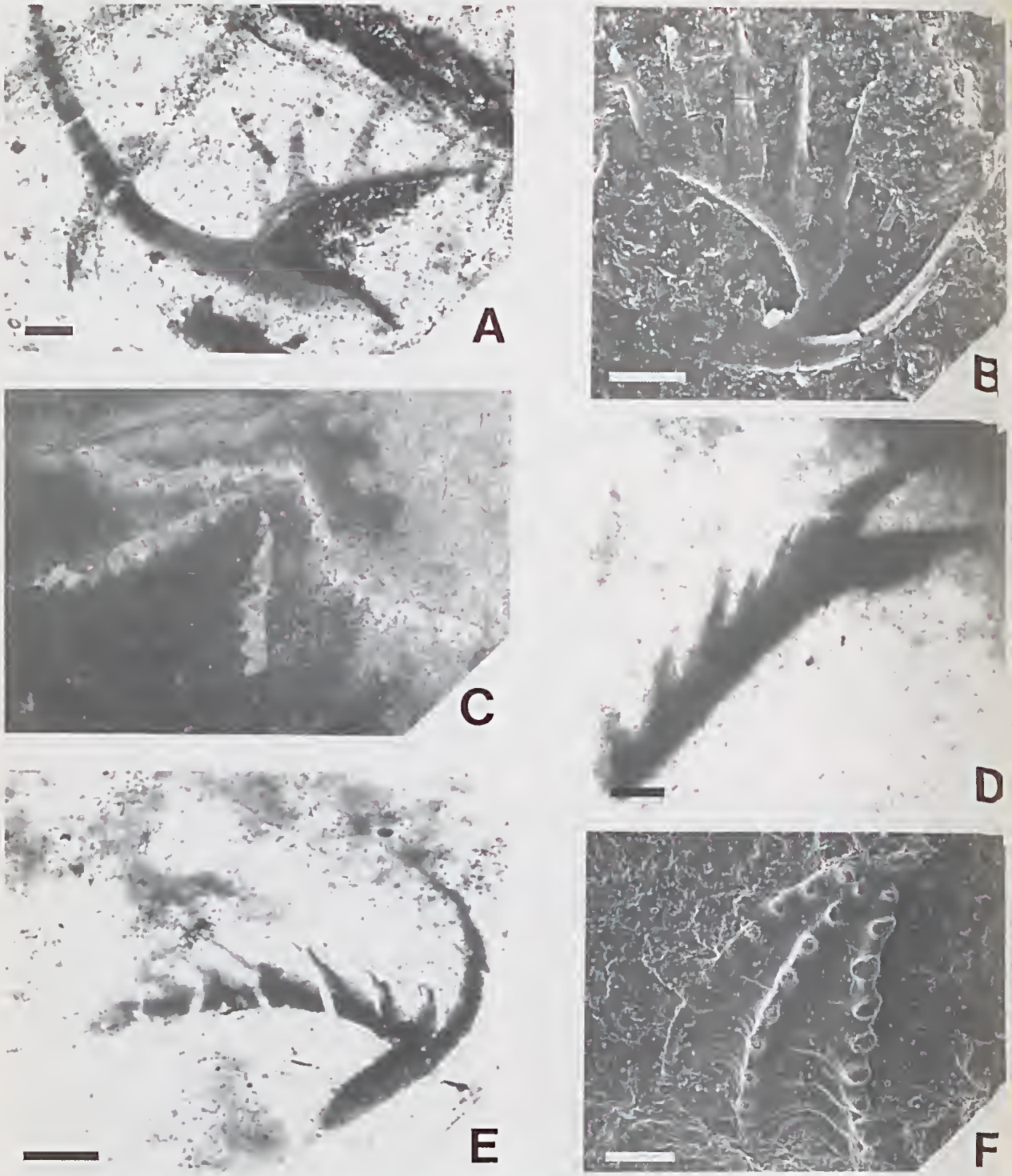

Fig. 3—A, *Cordylodus proavus* Müller, P 112076, rounded element in chert matrix, locality PL 199. B, *Paracordylodus gracilis* Lindström, P 112085, S. element. S.E.M. of latex replica, locality PL 2946. C, *Tetragraptus fruticosus* (Hall), P 112082, 4-branched form, locality PL 2946, X 3.5. D, *Bergstroemognathus extensus* (Graves & Ellison), P 112083, M element in chert matrix, locality PL 196. E, *Paracordylodus gracilis* (Lindström), P 112084, S element in chert matrix, locality PL 2948. F, *Pygodus serrus* (Hadding), P 112081, stelliscaphate element, S.E.M. of latex replica, locality PL 193. Bar scale is 0.1 mm. Specimen numbers and locality numbers refer to the Museum of Victoria Palaeontological collection register.

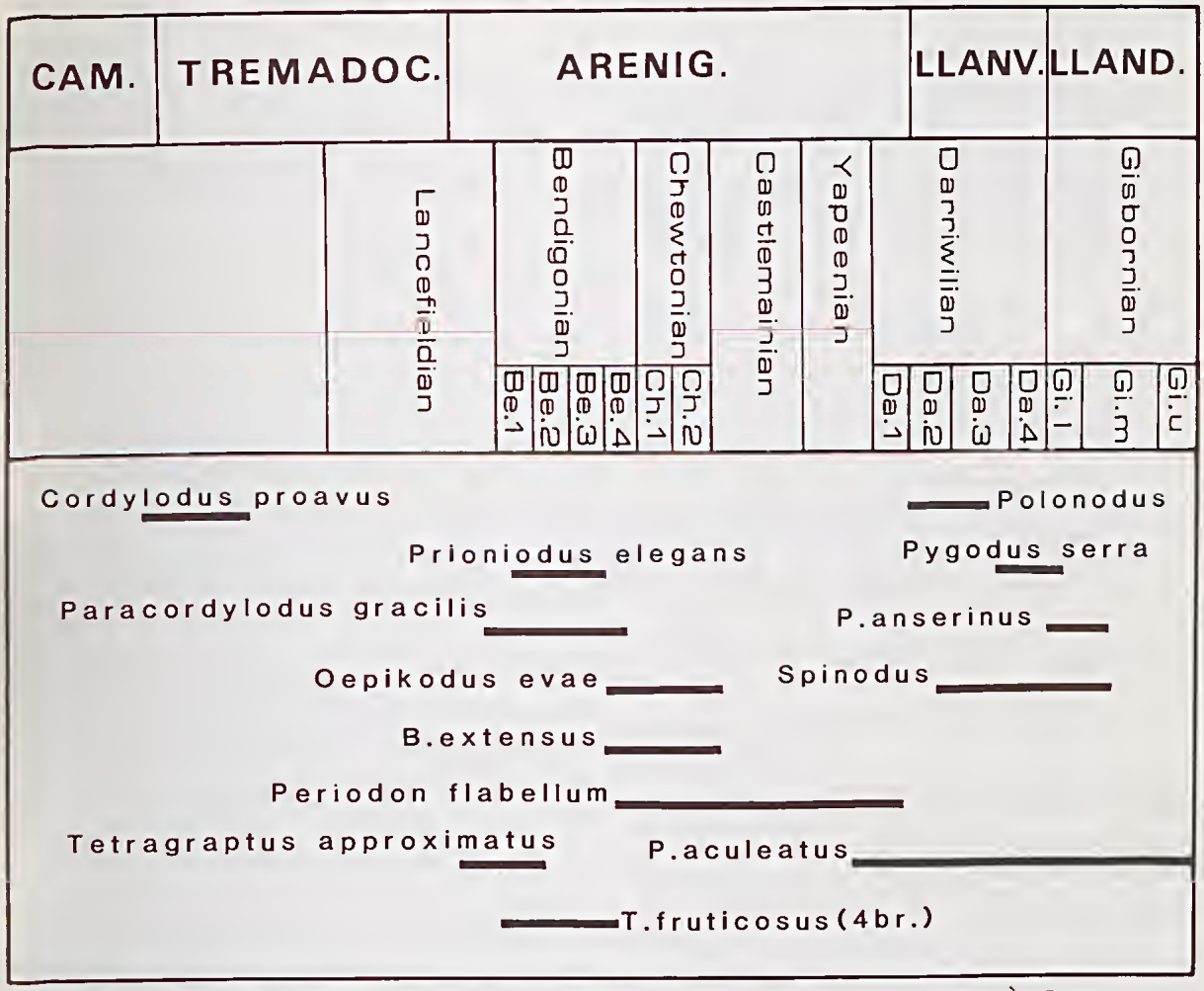

Fig. 4—Chart showing the range of key conodont and graptolite taxa recovered from the Hotham Group.

Conodonts have only been found at one black shale-nodular chert locality to the south-west of the Wonnangatta Line (PL 2947). Here, the presence of conoform conodonts and phyllocarids are consistent with a Lower Ordovician age (Fig. 1C).

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